not pride, or romance, or vainglory, but simply the sober necessities of business. And what young man is there with soul so base that the beautiful geometry of this work would not appeal to him and be a more than sufficient compensation for the tribulations arising from the analytical work? The mind of the chemist, unlike that of his future colleague the engineer, really dwells in a point. He lacks the sense of space and the power of thinking spatially, or, rather, most of his work tends to produce that lack. What better corrective could there be than the study of a four-component system? If the chemist is going to rule the world—as he hopes and as he ought—he must cease to be a point-man. He must become an understander and controller of space. If not, well, then the engineer will occupy the space, and the poor old chemist will continue to sit at his point and wonder what is wrong—as he has done these many years.

In the preface to his book Dr. Clibbens gratefully and gracefully expresses his indebtedness to Capt. Francis Arthur Freeth, under whom he studied the science of phase-equilibria in the research department of Messrs. Brunner, Mond, and Co. There is also an introduction by Capt. Freeth. No doubt Dr. Clibbens would be the first person to admit that this book is really a product of the Brunner, Mond Research Laboratory, and therefore of its director, Capt. Freeth. During the past fourteen years the science of heterogeneous equilibria and its practical application have reached a degree of development by Capt. Freeth, which is unequalled in any part of the world. Known to very few before the war, this fact became revealed to many by the magnificent work which Messrs. Brunner, Mond, and Co. did in connection with the manufacture of ammonium nitrate by three different methods. It is an open secret now that the work which this company did in this field alone saved the cause of the Allies at a critical stage. The final method which they employed—namely, the direct production of ammonium nitrate from sodium nitrate and ammonium sulphate, was a splendid triumph of scientific industry. Success was due to the intimate co-operation of scientifically trained directors and engineers with the Chemical Research Department; but the former would be the first to admit that, without the exact data yielded by Capt. Freeth's series of phase-isotherms, no successful process—indeed no process at all—could have resulted.

There have been many books dealing with heterogeneous equilibria, from the pioneer text-books of Bancroft and van't Hoff to those of Findlay and Kremann. Foremost amongst the more fundamental treatises stands, of course, the great work of Roozeboom, ably continued by Schreinemakers, with which may be classed the "Gesättigte Lösungen" of Jänecke, and the "Ozeanische Salzablagerungen" of van't Hoff. The present work of Dr. Clibbens is the first book in English to attack seriously the real geometry of the subject. He carries us from the delightful simplicity of binary systems right up to the real thing—quaternary and quinary systems. It is evident that Dr. Clibbens can think in space, and expects his readers to do the same. That is certainly necessary; but if one might cavil at all it would be to suggest that the author follows Schreinemakers a little too closely in his method. In leading the novice up the steps of Parnassus Dr. Clibbens has no mercy in his geometrical logic. As the mind of the ordinary man—and especially that of the chemist—gets abstract only by gentle degrees, it would have been well if the author had paused, at each stage in his heavenward journey, to work out *thoroughly*, both geometrically and arithmetically, a typical concrete case; and in his admiration for triangular co-ordinates he fails to do justice to the less general but very useful system of open rectangular co-ordinates.

But these are small matters in comparison with the great value and excellence of the book. It is one which every chemist must study and digest, and it is certain that it will have a great and salutary effect on the rising generation of English-reading chemists. Messrs. Brunner, Mond, and Co. are to be heartily congratulated on the important contribution which their research department has made to the advance of chemical science.

To the young chemist of the present day one may say these words. Study the mighty atom and its still mightier inside. Study also the organic molecule with its trailing field of glory and its vibration-frequencies; but if you want to be a man amongst men in the great world that toils with large masses do not "jump" the geometry of heterogeneous equilibria. It is the key that unlocks many doors.

Practical Anti-tuberculosis Work.

Industrial Colonies and Village Settlements for the Consumptive. By Sir German Woodhead and P. C. Varrier-Jones. With preface by Sir Clifford Allbutt. Pp. xi+151. (Cambridge: At the University Press, 1920.) 10*s*. 6*d*. net.

NO one wishing to be prepared adequately for practical anti-tuberculosis work can afford to neglect this little volume. Its authors are well known for their protracted studies of the subject, which are embodied in the present volume. We could have wished that the different essays and addresses, which form the larger part of the book, had been rewritten in more regular sequence, for this would have saved the reader's time and conduced to more impressive exposition. However, the whole of the work deserves study, and there is something to be said in favour of repetition of the same theme from a new angle.

There cannot be said to be anything exactly new in the book, except in the important particular that what others had discussed and regarded as desirable, in the Cambridgeshire colony described in this book, has been shown to be practicable and competent to bring improved results in the treatment of tuberculosis. There is, with the possible exception of syphilis, no disease which better illustrates than tuberculosis the synthesis and inseparability of treatment and prevention. Each patient treated successfully is thereby deprived of the power of infecting others; and each patient who, apart from cure, is taught during treatment the hygiene of his disease, and made to believe practically that his own recovery, as well as the safety of others, depends on his adopting hygienic precautions in coughing and expectorating, is an added influence towards the extermination of tuberculosis. There is appositeness in the illustration, that just as Sir Arthur Pearson said to his blind pupils: "The first thing you have to do is to learn to be blind," so the consumptive must "learn to be a consumptive," and to play the game both for himself and for those about him. It is because so many sanatoria have failed to impress this lesson, and to make it part of the life of the consumptive, that the loafing habit has been encouraged, and even partial return to industrial efficiency has been exceptional.

Others before the present authors have advocated farm colonies, industrial colonies, after-care associations, and allied agencies, and much good work has been done. At the Bourn and Papworth colonies a demonstration has been made of the practicability of dealing with all classes of consumptives at one institution. This practical application of the *vue toute ensemble* is especially valuable, particularly so when the views adopted by the authors of this book on the pathology of tuberculosis and the essential measures for its prevention are those which offer the greatest prospect of success. We all know that the infection of tuberculosis cannot be entirely avoided, but that practical danger arises only when the dosage of infection surpasses the powers of resistance. Hence minimisation of infection and measures for improving general health must go hand in hand.

The authors speak with authority on the importance of preventing the spread of massive infection, of "turning off the tap before we begin to empty the trough." Again: "Small doses of tuberculous virus *may* be harmless, large doses *must* be guarded against." They quote Sir Arthur Newsholme's conclusion that the admission of a large proportion of advanced consumptives to infirmaries has lessened the spread of disease, and add that this "points the way to the next step—the segregation of these middle cases in colonies, where, with the best chance possible of recovery, they also cease to be a source of infection to others." It is on this principle that the Cambridgeshire Tuberculosis Colony is based. It is an all-round scheme, covering every grade of tuberculosis: "We are satisfied that it is impossible to keep tuberculous patients in watertight compartments," and therefore early, middle, and advanced cases are treated in separate divisions of the same institution, which comprises the hospital at one end of the scale, the village settlement at the other, with intermediate rest houses for febrile patients, open-air shelters, hostels, and workshops. Here the patient has a reasonable hope of being made, not into a valetudinarian, but into a useful and productive member of society, who, although he may remain a consumptive, can even enjoy his life.

This is a hopeful view of the problem. Such institutions have a definite and increasing possibility of utility. It would, of course, be a mistake to assume that colonies of this kind cover the whole problem. They could not do so unless they were adopted on a gigantic scale; for various reasons a large number of chronic, but incurable, consumptives will need to be dealt with in urban homes, in hospitals, and in their own homes. A large proportion of partially recovered patients will recover only 75, 50, or 25 per cent. of their full working capacity, and there is need for the further organisation, on a scale commensurate with the magnitude of the problem, of provision for them of the three desiderata which are quoted by the authors of this book from an official report in the following words: "If the patient is to have the best possible prospect of recovery, and if his family are to be safeguarded against infection, in many cases he will need (*a*) improved housing; (*b*) occupation adapted to his physical capacity, etc.; (*c*) the family income will need to be supplemented. These requirements for many patients have not hitherto been met."

The last section of the volume is an admirable summary of the subject. We hope it will be read by, and give fresh heart to, all engaged in national tuberculosis work. We wish it could be brought home also to the hearts and minds of central and local governing bodies, who, unfortunately, at the present time, are engaged in whittling down essential public health activities, which is anything but economy of the welfare of the Commonwealth, on which efficiency depends.

Physics and Chemistry of Bioluminescence.

The Nature of Animal Light. By Prof. E. N. Harvey. (Monographs on Experimental Biology.) Pp. x + 182. (Philadelphia and London: J. B. Lippincott Co., 1920.) 10*s.* 6*d.* net.

BIOLUMINESCENCE—that is, the production of light by animals and plants—is a phenomenon which has excited wonder in the layman and given rise to many investigations on the part of the man of science. Since the results of these investigations, many of them of a purely qualitative nature, are widely scattered in the literature of various countries and not always readily accessible, the author has rendered a distinct service in collating the various facts and presenting them to the scientific public as a connected whole. The biological aspect is referred to but briefly, in a chapter on the structure of the luminous organs, the main portion of the book dealing with the physical characteristics of animal light and the chemical processes underlying its production. The study of bioluminescence is another instance of the application of physics and chemistry to biological and physiological problems; the author's treatment is clear and, so far as the present state of our knowledge is concerned, convincing; it shows, moreover, that he has full command of the cognate sciences.

After providing, in the first two chapters, an account of the physical phenomena of luminescence and incandescence, in which, especially, the various kinds of luminescence are adequately discussed, a detailed description is given of the results obtained in the physical investigations of the nature of animal light. It is in such physical investigations that most progress of a definite nature seems to have been made. Exact quantitative measurements have established that the light emitted is in no way different from ordinary light, except in intensity and spectral extent; it is all visible light, containing no infra-red or ultra-violet radiations or rays which are capable of penetrating opaque objects. Like ordinary light, it will cause fluorescence and phosphorescence of substances, affect a photographic plate, cause marked heliotropism of seedlings, and stimulate the formation of chlorophyll.

The efficiency (= visible radiation × visual sensibility ÷ total radiation) of the firefly as an illuminant seems to be of the order of 96 per cent.—that is, immeasurably superior to any artificial source of light. The light, however, supposing it could be put to use, would not be suitable for artificial illumination, since all objects would appear a nearly uniform green hue. Although the light of the firefly is the most efficient known, so far as amount of light for expenditure of energy is concerned, it has been produced at the inevitable expense of range of colour.

The last three chapters deal with the chemistry of light production and the dynamics of luminescence. As is only to be expected from the nature of the case, the chemistry of bioluminescence has not yet been placed on a basis as satisfactory as the physics thereof; the evidence, as yet, is mainly of a qualitative nature. It seems to be established that, in at least three groups of animals, luminescence is due to the interaction of two substances, luciferin and luciferase, in the presence of water and oxygen. Luciferase is a protein, all its properties agreeing with those of the albumins, and may be regarded as an enzyme; luciferin has many properties in common with the proteoses and peptones, but its chemical nature still remains to be decided. The stage to which our knowledge of the dynamics of animal luminescence has advanced may be indicated by the fact that the author only commits himself to the statement that "perhaps the reaction takes place in two stages," a compound luciferin–luciferase being first formed and then undergoing oxidation.

A valuable bibliography is given at the end of the book, which is printed in clear type and well supplied with illustrations and diagrams.

T. S. P.

Our Bookshelf.

The Arithmetic of the Decimal System. By Dr. J. Cusack. Pp. xvi + 492. (With answers.) (London: Macmillan and Co., Ltd., 1920.) 6*s.*

Dr. Cusack is a firm believer in the decimal system, and there can be no doubt that he speaks with some authority, in view of the great experience he has enjoyed of teaching arithmetic and other branches of a business training to all classes of pupils. Many have argued theoretically about the educational and commercial advantages of a